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ACCUMULATION AND RENEWAL OF FIXED CAPITAL IN EXPANDED REPRODUCTION

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I

In Part III, Volume II of *Capital*, Marx has analyzed the balance conditions of reproduction of fixed capital with replacement in natural form in the case of simple reproduction. But as for expanded reproduction, he has left no comprehensive analysis except a few fragmentary phrases. Yet fragments contain the following important sentence which almost everyone uses as the starting-point when he tries to discuss this unsolved problem:

> Even assuming that, on the basis of simple production on the same scale, the productivity of all lines of industry, and thus the proportional relations of the value of their commodities, would remain unchanged, there would nevertheless be an incentive for production on an enlarged scale whenever the two last named cases may occur, in which IIc (1) is greater or smaller than IIc (2)—(*Capital*, II, p. 543.)

In the case of simple reproduction, it is necessary and reasonable to assume that part I (hereinafter referred to as f that means a part of renewal of fixed capital) equals to part 2 (hereinafter referred to as d that means a part of depreciation of fixed capital) in order to draw the balance conditions of reproduction. But Marx maintains that the relation $f \lesseqgtr d$ is "unconditionally" possible in the case of expanded reproduction. The word "unconditonally" naturally implies that the relation $f \lesseqgtr d$ is not only compatible with the balance conditions of expanded reproduction as a whole, but must be a part of the conditions. How is this possible? In this article I should like to examine, with Marx' suggestion in mind, what new balance conditions of reproduction are added in the expanded reproduction as a whole if we take into account the condition of renewal of fixed capital.

II

1. Before starting the discussion, I will mention several points which are to be considered regarding renewal of fixed capital in the case of simple

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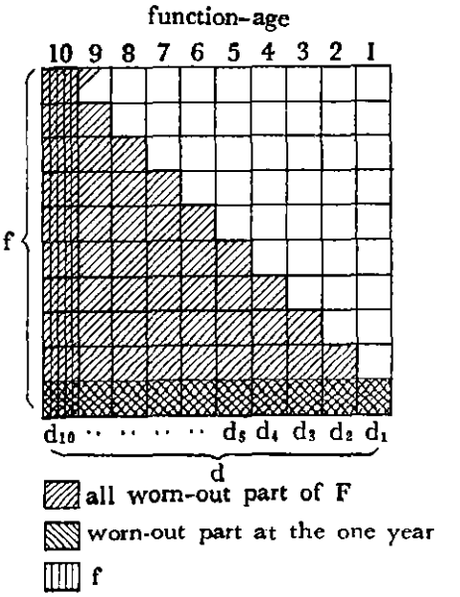
reproduction, if we are to analyze balance conditions of expanded reprodnction. Let us assume that the following simple reproduction diagrams are given in the n-th year.

I. 4000 C+1000 V+1000 M=6000
II. 2000 C+ 500 V+ 500 M=3000

In these diagrams, if d, the values of the worn-out part of fixed capitals in the n-th year, are IC 400 and IIC 200, and if the period of service of every fixed capitals is ten years, then IF will be 4000 and IIF 2000. If the total of those fixed capitals are equally divided to each year of service, (functionage from first year to tenth) and one tenth of the value of each $F^{\circ}(F_1,\ldots\ldots F_{10})$ is worn-out every year, and if one tenth of the total of F has been yearly renewed for the past ten years, the present state of worn-out part in every fixed capital and the hoard of the depreciation fund in monetary form will be as follows.

The part F_{10} which was renewed ten years ago will be completely worn out at the end of n-th year and must be renewed in natural form, while regarding the other parts $F_9 \ldots F_1$, 9/10, 8/10...1/10 will be worn out respectively, the value of which must be hoarded in money. If the yearly worn-out part of the capital per each year of service is represented as d_{10}, d_9,...d_1 respectively, the total of worn-out part at the end of n-th year is $10\ d_{10}+9\ d_9\ldots\ldots+1\ d_1=55d_0$, among which the worn-out part in the n-th year is $d_{10}+d_9\ldots+d_1=10\ d_0$. In other words, as $10\ d_0=d$, $f=d=10\ d_0$.

2. In the first place, if the money which equals to the worn-out part must be completely in hoard for the coming renewal, the amout of $45\ d_0$ must always be in existence, since we can exclude $10\ d_0\ (=f)$ which is necessary for the renewal of F_{10} at the end of n-th year. But actually the amount of necessary money for yearly renewal is $d_{10}+d_9\ldots+d_1 = 10\ d_0$. In other words, we need only $10\ d_0$ out of $55\ d_0$ each year to realize the balance condition of f=d, and the rest of the money ($45\ d_0$) does not need to be retained in the hand of each functioning capitalist. If the money is smoothly collected when each fixed capital needs to de renewed, he can lend it to a capitalist of other industry or use it as a capital of his own expansive investment, without causing any trouble to the renewal. This is an important point when we consider the problem of expanded reproduction.



3. Secondly, as for fixed capital functioning in simple reproduction, if F_{10} is renewed for the first time since its investment, the capitals F_1 to F_9 are all in their second period of service after the first renewal. But when we see them as the currently functioning fixed capital in natural form, it is evident that $d_1 \ldots d_9$, the worn-out values of $F_1 \ldots F_9$, are sold unilaterally and convert in money form, but the whole fixed capitals of $F_1 \ldots F_4$ continue to function in natural form in next year. The only exception is F_{10} which is completely renewed in natural form as soon as the last tenth (d_{10}) is realized in money at the end of the year. It is because unilateral purchase for renewal is made, which equals to the total worn-out value, that, in spite of all this, social products are realized with balance and that there is no difficulty in the yearly flow of money.

Lastly every fixed capital has a period of "the very beginning" when it has been first invested. Of the currently functioning fixed capital F which is simply reproduced every year, its one tenth (F_0) has been yearly accumulated at "the very beginning" of capitalism and, after the tenth year, they ($F_1+F_2 \ldots +F_{10}$) are only renewed with no new accumulation, but there are no fixed capitals to be renewed in natural form from the first to the ninth year. Therefore we should think, that only unilateral sale of part d is made and then it is impossible to keep the balance with unilateral purchase for renewal that equal to unilateral sale. At least the balance f=d is not possible until the end of the tenth year when f as the renewal value of F_{10} equals to d= (the total of d_{10}, $d_9 \ldots d_1$). It is also impossible for the part of unilateral sale in the period of "the very beginning" to be supplemented with unileteral purchase in the future, for when unilateral purchase for renewal, begins it will be accompanied, as a condition of the yearly balance of reproduction, with unilateral sale of part d in the same year. Thus the period of "the very beginning" of accumulation is unique in that there is no unilateral purchase to correspond to unilateral sale. Therefore the assumption concerning simple reproduction that unilateral sale always corresponds to unilateral purchase does not apply to "the very beginning" but to the period after the first renewal has started. Atherwise in expanded reproduction, newly invested fixed capital from surplus value of every year must have a same character of such "beginning capital". In this sense, we can think that the assumption of simple reproduction which not consider "the very beginning" is abstract.

III

1. Let us take a year of expanded reproduction from many years in the

current and show its total reproduction in the following diagrams. The year will be referred to as n.

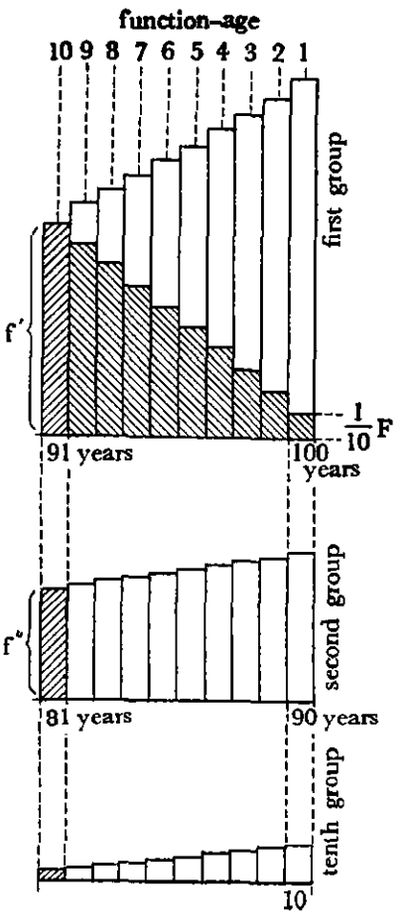
I. 4000 C+1000 V+1000 M=6000
II. 1500 C+ 750 V+ 750 M=3000

At the end of the n-th year the worn-out values of fixed capitals (d) are, from the premise, IC 400 and IIC 150. If we investigate this part more in detail, we shall find that it contains not only the first worn-out value of fixed capital, which was additionally invested from part M in the previous year (the end of the year n-1), but also the worn-out value of fixed capitals newly invested at the end of the years n-2 ... n-9. None of them need to be renewed in natural form and so they are hoarded as soon as it is converted in the form of money. The only problem concerning them is unilateral sale. In other words, there is the same problem that occurs in "the very beginning" which we ignored in discussing simple reproduction. But now we cannot ignore this newly invested part since it is the most imporent point of the problem. Thus the question is how to keep the balance of the whole reproduction with this part of unilateral sale as its indispensable element.

2. Secondly, if organic structure of capital, surplus value rate and rate of accumulated part of surplus value are constant, additional fixed capital proportionally increases every year. Therefore if we can presuppose smoothly expanded reproduction, both additional fixed capital and its worn-out part (d) gradually increase.

2. With these points in mind, let us assume that the n-th year is the one hundredth year since birth of capitalism, and investigate the conditions of fixed capital.

New fixed capital has been additionally invested every year for the past hundred years. We can divide those years into groups of ten years, starting from the year-n to the very first year. The first group includes the additional fixed capital newly invested from the one hundredth to ninety-first year, and similarly we can make nine more groups, as the Plate 2 shows. As



the result of yearly expanded reproduction, additional fixed capital proportionally increases every year, which, if we trace back the past years from the n-th year, gradually decreases. Therefore in the first group, the new additional fixed capital of the year-n is the largest, while that of the ninety-first year is the smallest. The largest additional fixed capital of the second the ninetieth year, is even smaller than that of the ninety-first year, the smallest in the first group. In this way, every group of fixed capital gradually decreases from the first to the tenth group.

According to the presupposition, the service period of each fixed capital is ten years. Therefore at the end of the n-th year (the 100th year) additional fixed capital of the ninety-first year is completely worn-out and needs to be renewed in natural form. On the other hand, as $F_{92}...F_{100}$ are larger than F_{91}, there is a relation of $d_{91} < d_{92} < \ldots < d_{100}$ concerning worn-out part of each fixed capital in the n-th year. Therefore $10\ d_{91}=f'$ (renewed part of the first group in the n-th year) is smaller than d', the total of d_{91}, $d_{92}...d_{100}$.

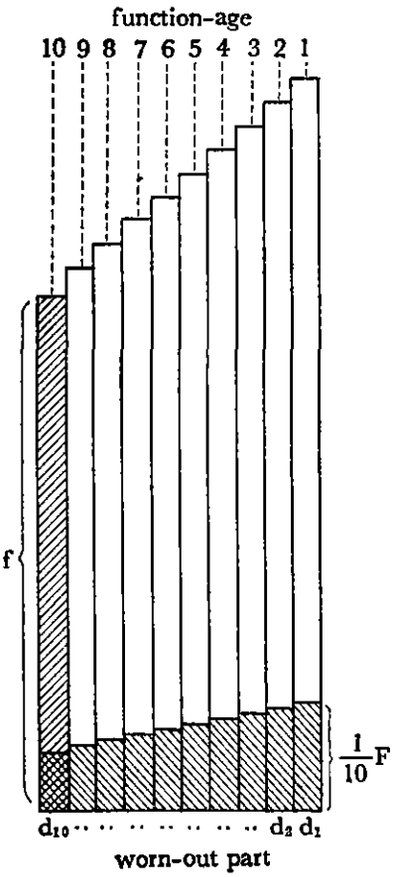
Regarding the second group of which f'' is smaller than d'', each capital was newly invested from the eleventh to twentieth year and is in the second period of service, after being completely worn-out and renewed in natural form.

But as for the service age of the now functioning fixed capitals in natural form, it is from first year to tenth year whether or not they has been renewed, just as fixed capital of the first group which has been newly invested during the last ten years. In this way F_{81}, the service age of which is tenth must be renewed in natural form together with F_{91} at the end of the n-th year. In this case $10\ d_{81}$ is smaller than the total of $d_{82} + d_{83}... + d_{90}$ and f'' is smaller than d''. The same relation can be caused about the other eight groups. The only difference is that fixed capital to be renewed gets smaller as we come nearer to the tenth group.

3. There is the same relation if we choose the year n+2 (the 102th year) as the starting-point. In this case, the first group includes from F_{102} to F_{93} the second from F_{92} to F_{83}, and so forth, and there is no difference concerning other conditions, especially the relation of $f < d$ in each group but the fixed capitals invested in two years of the "very begining" cannot be included in these ten-year groups, and we can discuss only unilateral sale regarding d_1 and d_2. If we choose hundred the 109th year the fixed capitals invested in first nine years of the "very beginning" with no renewed part in the same year make a rump group, in which only unilateral sales are made. How should we deal with this rump group? If we see the matter quantitatively, as yearly additional fixed capitals, according to the presup-

position, gradually decrease toward the past, we can practically ignore them near the end as a differencial quantum. In other words, there will be no inconvenience at all, even if we ignore the rump group and deal only with ten-year groups. It is supported from historical point of view, since, as Marx has pointed out, the amount of capital originally accumulated gets more negligible in comparison with that accumulated by transformation of surplus value, when capitalistic production develops and the total amount of capital gets more enormous. Capitalism, with an infinite possibility of accumulation caused by its own surplus value, establishes itself as a form of production which develops with an explosive expansion. "A year in the current of many years" is nothing but a year of such kind of completed capitalism.

4. Of the above-mentioned groups, if we ignore the year that each fixed capital has been invested at first, and consider only its service age, every capital has a service age from one year to ten years. Plate 3 shows their condition classified according to their service age. In this case, the largest fixed capital in each group is that with a service age of one year, and the longer it is the smaller the capital is, the smallest being that with a service age of ten years. Therefore, if we classify them according to their service age, the largest group (F_1) is the one with a service age of one year and the smallest (F_{10}) is the one with a service age of ten years. The same relation can be caused about d_0 of each group classified in the same way, and herein once more $d_{10} < d_9 \ldots\ldots < d_1$, and $f < d$ are found. Therefore $f < d$ is a common condition of reproduction of the whole fixed capital.



IV

1. If the relation $f < d$ is a common condition of expanded reproduction, how is the balance condition of expanded reproduction fulfilled? In the case of simple reproduction, the relation $f < d$ destroys its balance condition and leads to a possibility of a panic. Let us assume that, among the

fixed capital of division II, 180 C must be renewed at the end of the n-th year, while the value of worn-out fixed capital in the same year is 200. The capitalist IIK_1 who has to renew his own fixed capital purchases fixed capital goods 180 from part M of the products belonging to the capitalist of division I (Ik). With the money 180 paied by IIK_1, IK purchases consumer products of the same value from a capitalist IIK_2, who has to change his product into money and hoard the worn-out value of his own fixed capital. In this process, IIK_2 can change into money only 180 of IIC d (200) and 20C is left as it is unrealized.

If IK needs consumer products worth 200, 20 is still in demand. In case IK expends 20 out of his reserve money in order to fulfill this demand and purchases 20C, which is left unsold, from IIK_2, IICd (200) is completely realized and the equivalent money goes into hoard. There is no question about 180 of that amount since it goes out of and comes back to IIK, but 20 does not return to IK. The difficulty just likes to be solved by the money from " nowhere ", but this solution is not consistent with our presupposition.

On the other hand, let us assume that products of 20 are left unsold in the hand of IK. In this case, if IIK expends money of 20 and purchases them from IK and IK with the money purchases consumer products of 20 left unsold in the hand of IIK_2, the whole products are realized, and money returns to its original division and apparently there seems to be no question. However the necessary renewal for IIK_1 is done by purchasing fixed capital products of 180, and therefore additional purchased fixed capital products of 20 mean entirely new investment. In other words renewal is accompanied by accumulation. This solution does not fulfill the condition of simple reproduction, but if we admit the assumption of expanded reproduction, there seems to be no question from the viewpoint of circulation of commodity and money, since all commodities are realized and all moneies return to there original place.

2. We have already seen that the relation $f < d$ is a common condition of expanded reproduction. In this case the question is how to realize the part d–f. If it is solved in the same way as the realization of 20 (200d–180f), there is no contradiction to the presupposition which originally included the assumption of expanded reproduction. But still there are several question to be answered.

The first is where IIK_1 should get the additionally expended money (20 in the example above).

The second is whether this money causes any disturbance in the process of reproduction, for even though it returns to division II, it is not to

IIK_1 who expended it, but to IIK_2.

The third is concerning the additional fixed capital (20) acquired by IIK_1. How should he get the circulating constant capital and variable capital? Are the balance conditions of reproduction disturbed in connection with the part of M which is simulataniously carried out for accumulation?

3. The first question:

Generally in expanded reproduction, as the total amount of circulating commondity absolutely increases, the amount of money which is to mediate this circulation must correspondingly increase if the velocity of circulation is constant. But in this article about reproduction, we shall assume only "as every where, metalic circulation in its simplest form", "because then the flux and reflux, the balancling of accounts, in short all element appearing as consciously directed processes under the credit system, appear as forms independent of the credit system, show themselves in their primitive form instead of their later reflected on (Capital II p. 585). In other words actual circulation of money is inconceivable without credit system, but circulation of money is essentially controlled by the conditions of reproduction themselves. So long as credit system, corresponding to this control-relation, stimulates money circulation and does not throw into disturbance the normal process of the whole organism of reproduction, we can assume credit with no trouble at all. If we assume only metal currency circulation, we must exclude every kind of its disturbing action such as rise in prices caused by a sudden increase of precious metal production and fall in prices of gold. The point is that, so long as we assume metal currency circulation, we must think it depends on the value of gold. But then, as absolute increase of metal currency depends on the production of gold, the increase of necessary money caused by expanded reproduction is restricted by the production of gold which greatly controlled by a natural factor, and so we might lead to "an absurd conclusion" that the scale of capitalistic production has to depend on the production of gold. But actually development of credit system saves the amount of circulating money and thus supplies with additional circulation. Addition caused by the production of gold plays only a secondary part.

The source of credit system is hoarded money, which is inevitably formed by various factors in the process of reproduction, and the necessary amount of circulating money is saved by using it. It means that additional money supplied by credit is essentially hoarded money. Additional money necessary in the process of expanded reproduction is chiefly supplied by hoarded money staying in various places of the reproduction process and secondarily by the production of gold. Credit system saves necessary amout

of circulating money and mobilizes hoarded money.

Thus we can assume that additional money in expansion of production is infinitely supplied when necessary by hoarded money and the production of gold, and, so long as no disturbance towards reproduction is caused by the currency by credit system.

4. The second question:

As we have seen in the case of simple reproduction, if a capitalist must have in hoard the money worth the total worn-out value of the whole fixed capital, its amount is $55d_0$ or 5.5 times as much as f. If f equals to d, the money expended for f yearly returns to the original division when Cd is realized, and therefore actually the necessary a mount of money is merely worth f for normal renewal of fixed capital. In other words, hoarded money worth 1f out of 5.5f functions yearly in the process of circulation. We have assumed that IIK_1 replaces f in natural form by expending renewal fund, which he has acquired by hoarding the money worth yearly worn-out value for ten years. But now let us assume he does it with bank loan. If bank supplies money for purchasing fixed capital goods at the time of the original investment, the money collected by realization of yearly worn-out value is immediately repaid to the bank and does not stay in the hand of the capitalist. The same amount of money flows out of and into IIK every year. In this case, even if the money worth f exists in the bank, there is no trouble in the process of reproduction. In either case the hoarded money worth 4.5f is isolated. It is not because credit system has a magic power to produce something from nothing. It is merely an objective result of reproduction process which is regularly repeated without any trouble under the balance condition of f=d.

According to the assumption above, IIK_1 replaces his own hoarded money worth 180 in fixed capital of natural form and, in addition to that, purchases fixed capital goods worth 20. This, of course, means accumulation of new fixed capital worth 20. On the other hand, as d (IIC) is 200, its realization means collecting in the hand of IIK the total amount of money (180+20) which IIK_1 expends to purchase fixed capital goods from IK. Out of that amount, there is no question about the exchange of 180f and 180d. But we have to pay attention to the money worth 20 which IIK_1 newly invests. Whether it is his own hoarded fund or bank loan, every capitalist of IIK_1 can gradually repay the value of 20 for the coming ten years only by realizing worn-out value of one-tenth of the new additional fixed capital, but as for the whole of division II, it has to collect the money worth 20 in the year. This is done by realizing 20d of IIC, which IK purchase. Sooner or later this money for renewal of fixed capital of

IIK_2 will be necessary. It means that the money invested for expansion will become a part of the money necessary for simple repdocution. It will not used again in new additional investment. Therefore for yearly additional investment of part d-f the money must newly be thrown into division II. This kind of additional money is not special, but necessary in all additional investment, so long as the velocity of money circulation remains constant. Apparently it resembles the money thrown in from outside, with which unrealized products in simple reproduction is realized, but really it is quite different, for the money in simple reproduction does not become a permanent part of reproduction process even though it temporarily functions in the process, while the additional money in expanded reproduction becomes a part of simple reproduction process just as additional capital of the previous year becomes its part in this year. The only point to be noticed is that the money invested for additional fixed capital which is equivalent to d-f returns to its starting point in the same year, realizes the products of the same division in the same year and does not disturb the balance between the divisions, and functions as a part of simple reproduction process. Anyway as it eventually becomes a part of simple reproduction it is unseparatably connected with reproduction process once it is thrown in. The same thing can be said regarding d of division I.

5. The third question:

When investment, which is equivalent to d, is made only for fixed capital, the corresponding circulating constant capital and variable capital must be additionally invested from other source of accumulation which can be nothing but surplus value. Out of the capitalists of II, IIK_1 has accumulated surplus value in the form of money for the last few years and now can convert it to capital in natural form, the amount of which is A. On the other hand, the other capitalist IIK_2 continues accumulating money and the amount of his accumulation of this year is B. The relation $A=B$ is necessary in order to keep the balance in division II. In this case the proportion of various capitals which are the objects of investment of A is decided by organic structure of capitals, and the former remains constant unless the latter changes. But there is no reason why its proportional division should be made merely in A. What is necessary is that proportion between the three elements of capital should be kept inside the source of accumulation as a whole which includes d-f. In other words, the total of A and d-f should be taken into account in arranging various elements of production which are necessary for accumulation. If d-f furnishes only a part of additional fixed capital, A has to furnish merely the rest of additional fixed capital, circulating constant capital and variable capital. This will

cause no unbalance.

V

It is no miracle that worn-out part of existing fixed capital can thus change, if not wholly, into the source of accumulation. It means that more products which as a result of production go back to a capitalist, become additional fixed capital, and convert again into capital that brings forth surplus value in next process. It is essentially the same as the case in which variable capital and circulating constant capital are saved by development of productive power. The only difference is that in that case the result is possible by accumulation of capital for many years, regardless of a capitalist's intention.

Marx has said that reserve money for replacement can work towards expansion of reproduction from social point of view:

"This part of the value of fixed capital transformed into money may serve to extend the business or to make improvements in machinery with a view to increasing the efficiency of the latter. This reproduction takes plase in larger or smaller period of time, and this is, from the stand point of society, reproduction on an enlarged scale. It is extensive expansion, if the field of production is extended; it is intensive expantion, if the efficiency of the instruments of production is increased. This reproduction on an enlarged scale does not result from accumlation, not from the transformation of surplus value into capital, but from the reconvertion of the value which has detached itself in the form of money from the body of the fixed capital and has resumed the form of additioned, or at least of more effIcient, fixed capital of the same kind." (Capital III, Part 11, chap. VIII, sec, 11, p. 195.)

In other words, capitalistic production as a result of constant expansion has to continue some kind of accumulation, even when accumulation from part M is stopped. Otherwise existing fixed capital will not possibly be renewed and eventually simple reproduction will not be sustained. This can be a more serious factor of anarchy to capitalistic production.

We have seen that in expanded reproduction renewal and accumulation of fixed capital are deeply connected with each other and that it is impossible to treat them separately. Renewal includes accumulation and accumulated part of M cannot be independent. Therefore it is important to discuss the two together.

In the sentence of Marx quoted in the beginning of this article, he says that the relation $f \lesseqgtr d$ is inevitable in expanded reproduction, and we

have discussed only the case of $f < d$. There seems to be no doubt that it is a common condition of expanded reproduction. But it is not clear why the relation $f > d$ is unconditional, and the question is left as it is for the time being.